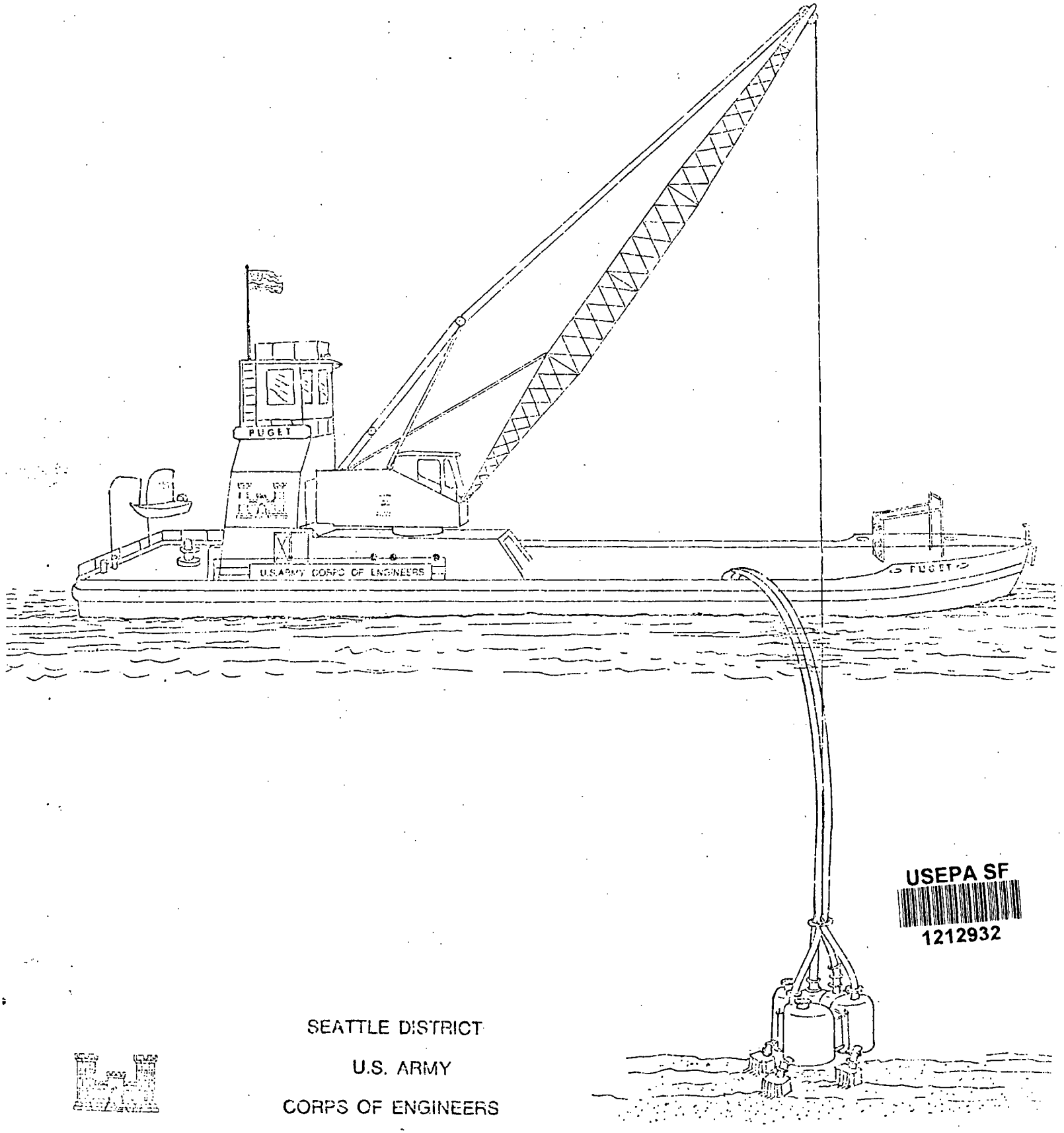
P.C.B. CLEANUP OPERATIONS

DUWAMISH WATERWAY

SEATTLE HARBOR, WASHINGTON



SEATTLE DISTRICT

U.S. ARMY

CORPS OF ENGINEERS

PCB CLEANUP OPERATIONS
DUWAMISH WATERWAY
SEATTLE HARBOR, WASHINGTON

1. BACKGROUND: AN ELECTRICAL TRANSFORMER CONTAINING POLYCHLORINATED BIPHENYLS (PCB'S) WAS DROPPED DURING BARGE LOADING OPERATIONS ON 13 SEPTEMBER 1974. AS A RESULT OF THIS ACCIDENT, 260 GALLONS OF PCB'S WERE SPILLED INTO SLIP 1 OF THE DUWAMISH WATERWAY, SEATTLE HARBOR, WASHINGTON. LOCATION (INCLOSURE 1) OF THE SPILL WAS APPROXIMATELY 3 MILES UPSTREAM FROM WHERE THE DUWAMISH WATERWAY ENTERS ELLIOTT BAY (PUGET SOUND).

WHEN THE WASHINGTON DEPARTMENT OF ECOLOGY (DOE) AND THE U. S. ENVIRONMENTAL PROTECTION AGENCY (EPA) REGION 10 FOUND OUT THAT THE CHEMICAL SPILLED WAS PCB, AN EMERGENCY REMOVAL OPERATION WAS UNDERTAKEN BY EPA IN WHICH DIVERS, UTILIZING SMALL HAND-HELD SUCTION DREDGED TO PUMP THE WATER, PCB'S AND CONTAMINATED BOTTOM SEDIMENTS INTO SETTLING TANKS, WAS UNDERTAKEN. AN ESTIMATED 70 - 90 GALLONS OF THE PCB WAS REMOVED DURING THIS OPERATION; HOWEVER, SAMPLING OF THE REMAINING SEDIMENTS INDICATED THAT LARGE QUANTITIES OF BOTTOM SEDIMENTS WERE CONTAMINATED AND A LARGER SCALE DREDGING AND DISPOSAL OPERATION WOULD BE REQUIRED.

AFTER REVIEW OF THE CIRCUMSTANCES SURROUNDING THE SPILL, THE U.S. ARMY MATERIEL COMMAND WAS ASSESSED LIABILITY FOR THE ACCIDENT. REASON FOR LIABILITY WAS DUE TO FAULTY PACKAGING OF THE TRANSFORMER. BY LETTER DATED 24 SEPTEMBER 1975, OVER ONE YEAR AFTER THE SPILL OCCURRED, THE SEATTLE DISTRICT CORPS OF ENGINEERS WAS TASKED WITH THE RESPONSIBILITY FOR REMOVING THE REMAINING CONTAMINATED MATERIALS. DURING

THE PRECEEDING YEAR, PERIODIC SAMPLING HAD BEEN ACCOMPLISHED BY REGIONAL EPA PERSONNEL. INDICATIONS WERE THAT THE SPILLED CHEMICAL WAS BEING DISTRIBUTED THROUGHOUT THE SLIP, WITH SOME MIGRATION TO THE ADJACENT WATERWAY. AT THIS TIME, EPA ESTIMATED THAT 2 FEET OF CONTAMINATED MATERIAL WOULD HAVE TO BE REMOVED ACROSS THE ENTIRE SLIP, WITH DEEPER DREDGING AT THE POINT OF THE SPILL. THIS WOULD ENCOMPASS THE REMOVAL OF APPROXIMATELY 27,000 CUBIC YARDS FROM THE SLIP AND 20,000 ADDITIONAL CUBIC YARDS FROM THE ADJACENT WATERWAY; HOWEVER FLOODING DURING DECEMBER OF 1975 DILUTED OR DISSIPATED THE MATERIAL IN THE WATERWAY TO THE EXTENT THAT ITS REMOVAL WAS NO LONGER REQUIRED.

2. <u>DISPOSAL SITE ACQUISITION:</u> THE FIRST AND PRIMARY DISPOSAL SITE CONSIDERED FOR THE CONTAMINATED MATERIALS WAS THE KELLOGG ISLAND SITE DIRECTLY ACROSS THE WATERWAY FROM THE SPILL SITE. THE SITE IS OWNED BY THE PORT OF SEATTLE AND HAD BEEN PREVIOUSLY UTILIZED FOR DISPOSAL OF DREDGED MATERIALS. DISCUSSIONS, NEGOTIATIONS AND CORRESPONDENCE FOR USE OF THIS SITE WERE CARRIED ON BY THE PORT AND THE CORPS OF ENGINEERS FOR APPROXIMATELY 3 MONTHS. THEN, BECAUSE IT WAS UNKNOWN WHAT THE FINAL UTILIZATION OF THE SITE WOULD BE, THE PORT INFORMED US THAT THE SITE WOULD NOT BE AVAILABLE FOR DISPOSAL OF THE PCB-CONTAMINATED MATERIAL. AFTER THE KELLOGG ISLAND SITE FELL THROUGH, NUMEROUS OTHER SITES WERE INVESTIGATED WITH THE PLAN OF PUMPING THE CONTAMINATED MATERIALS INTO LARGE BARGES, THEN TOW THE BARGES TO THE DISPOSAL SITE AND PUMP THE CONTAMINATED MATERIAL INTO AN EXCAVATED PIT NEAR THE SHORE. ALMOST EVERYONE CONTACTED INDICATED A GREAT RELUCTANCE TO CONSIDER ACCEPTANCE OF THE CONTAMINATED MATERIALS. MANY DISPOSAL SITE OWNERS INDICATED A DESIRE TO HAVE A

"HOLD FREE OF DAMAGES" CLAUSE IN THE LEASE AGREEMENT. ONLY BY CONGRESSIONAL ACTION COULD SUCH A PROVISION BE INCLUDED. DURING THE FIRST WEEK IN FEBRUARY, WHILE NEGOTIATIONS WERE BEING CONDUCTED FOR MANSON CONSTRUCTION COMPANY'S SOUTH PARK SITE APPROXIMATELY 3½ MILES UPSTREAM FROM THE SPILL, CHIYODA INTERNATIONAL CORPORATION INDICATED THAT THEIR PROPERTY 2,400 FEET SOUTH OF THE SPILL MIGHT BE AVAILABLE TO RECEIVE THE CONTAMINATED MATERIALS. AGREEMENT WAS REACHED AND CONTRACT SIGNED ON 11 FEBRUARY 1976 FOR THE CHIYODA SITE. THE SITE IS AN ABANDONED CITY OF SEATTLE SEWAGE TREATMENT PLANT. THE DISPOSAL PITS WERE EXCAVATED IN THE EXISTING SLUDGE PONDS.

3. CHIYODA DISPOSAL SITE: THE DISPOSAL SITE WAS PREPARED TO RECEIVE THE DREDGED MATERIALS, AS SHOWN ON INCLOSURE 2. TWO 25,000 CUBIC-YARD PITS WERE EXCAVATED IN THE EXISTING SLUDGE BED AREAS. THE MATERIAL EXCAVATED WAS UTILIZED FOR CONSTRUCTION OF DIKES AROUND THE PITS. A CROSS-DIKE WAS LEFT BETWEEN PIT #1 AND PIT #2 TO CREATE BETTER PONDING AND SETTLING OF THE DREDGED MATERIALS. A DREDGE SPILL BOX STRUCTURE ALLOWED DECANTED WATER FLOW FROM POND #1 TO POND#2. THE LARGE VOLUME PITS AND LOW DREDGE VOLUME REDUCED CROSS-SECTION FLOW VELOCITY IN DISPOSAL AREAS TO LESS THAN 1 FOOT/HOUR. CONSTRUCTION OF THE PITS STARTED ON 14 FEBRUARY, AND EXCAVATION WAS COMPLETED ON 28 FEBRUARY 1976.

4. PNEUMA DREDGE SYSTEM: THE DREDGING WAS ACCOMPLISHED BY USE OF AN ITALIAN MANUFACTURED PNEUMA MODEL 600 DREDGE FROM PNEUMA NORTH AMERICA INCORPORATED, HINSDALE, ILLINOIS. THE DREDGE, ALONG WITH 2,000 LINEAL FEET OF 10-INCH ID DISCHARGE PIPELINE, WAS TRANSPORTED TO SEATTLE IN THREE TRUCK TRAILER LOADS. THE TRUCKS ARRIVED RESPECTIVELY ON 23, 24, AND 25 FEBRUARY 1976. TWO SUPERVISORS FROM PNEUMA

NORTH AMERICA WERE ALSO CONTRACTED TO SUPERVISE THE DREDGE'S OPERATION. THE DREDGE WAS MOUNTED ABOARD THE CORPS OF ENGINEERS DEBRIS BOAT PUGET (CONVERTED NAVY YSD) WHICH WAS LASHED PERPENDICULARLY ONTO A 120-FOOT LONG SPUD BARGE WHICH ENABLED THE DREDGE TO MAKE A LARGE ARCH OR SWING DURING EACH DREDGE CUT. THE BOAT'S PROPELLERS WERE UTILIZED TO ACCOMPLISH THE ARCH TRAVEL RATHER THAN CONVENTIONAL ANCHORS AND WINCHES. THE WIDTH OF THE PNEUMA INTAKE STRUCTURE WAS 10 FEET. THREE 8-FOOT WIDE PASSES WERE UTILIZED BY VARYING THE BOOM ANGLE OF THE DREDGE UNIT ON THE BOTTOM PRIOR TO STEPPING AHEAD WITH THE SPUD BARGE. THIS TYPE OF HOOKUP HAD THREE DISTINCT ADVANTAGES:

(1) THE CRANE OPERATOR COULD RAISE OR LOWER THE DREDGE UNIT TO INCREASE OR DECREASE CUT DEPTH AND RATE OF THE TRAVEL. IN THIS MANNER, HE WOULD ASSURE THAT HE WAS TAKING A PROPER DEPTH OF CUT WITHOUT DREDGING EXCESSIVE YARDAGE.

(2) THIS METHOD ALSO ALLOWED HIM TO FOLLOW THE CONTOURS OF THE BOTTOM RATHER THAN MAKING A UNIFORM FLAT CUT AS CONVENTIONAL DREDGES WOULD HAVE DONE.

(3) THE VARIANCE OF THE BOOM ANGLE TO SET ANGLES DURING THE THREE CUTS AND THE POSITIVE FIXING OF LOCATION BY THE STERN SPUD ESSENTIALLY ASSURED 100% UNDERWATER SURFACE COVERAGE BY THE DREDGE UNIT.

5. THE PNEUMA SYSTEM FROM CHICAGO WAS UTILIZED BECAUSE OF ITS ABILITY TO PUMP HIGH CONCENTRATIONS OF SOLIDS AND ITS ABILITY TO DREDGE WITH VERY MINIMUM INCREASE IN BOTTOM TURBULENCE OR TURBIDITY INCREASE. THE HIGH SOLID CONCENTRATIONS WERE REQUIRED TO REDUCE THE TOTAL WATER VOLUME, WHICH WOULD REQUIRE FILTER TREATMENT. THE PNEUMA SYSTEM WAS POWERED BY USE OF THREE 1,000 CFM COMPRESSORS IN SERIES.

6. Flocculents Used: Nalco Chemical Company was contracted to supply the flocculents and set up the pumps and teach Government personnel how to administer the flocculent. Mr. Jim Dykstra was Nalco's representative. He was the salesman as well as the technical contact (telephone number is (305) 659-0143). His testing of sludge samples from the site indicated that a 20 part/million concentration of Nalco #7134 would be the most effective. He also indicated that the use of this chemical would reduce the swell of the material by approximately 50%. This is an advantage in reducing the size of the disposal areas required. Quantity of chemical actually used correlates with the 20 part/million. Approximately 500 gallons of chemical were used to treat the 10+ million gallons of slurry pumped.

7. This flocullent was very effective. At times, when heavy concentrations of slurry were being pumped, observation near the discharge showed that the turbid or dirty water expended only 20-30 feet out from the point of discharge. At this point, almost a curtain-like settling effect occurred. We have inadequate surveys to substantiate, but it appears that the chemical was also effective in reducing the amount of swell. Possibly one reason for the greater degree of effectiveness with this flocculent was that it was used continually through the dredging operations rather than waiting for a turbidity or settlable-solids problem prior to interjection. Total cost of personal services and 600 gallons of flocculent was only $3,300, which is a minor cost for the entire project.

EPA MONITORING: REGION 10, ENVIRONMENTAL PROTECTION AGENCY, CONDUCTED THEIR OWN MONITORING OF PCB MOVEMENT AND CONCENTRATIONS DURING THE INITIAL CLEANUP, BETWEEN CLEANUPS AND DURING THE FINAL CLEANUP OPERATION. MR. JOSEPH BLAZEVICH, PHONE (206) 442-5840, WAS THE HEAD CHEMIST ON THE ANALYSES. ANALYSIS CONSISTED OF DRAWING SAMPLES VIA PETERSON DREDGE OR CORE TUBES. SOLVENT WAS INTRODUCED IN THE LABORATORY AND PCB EXTRACTED VIA SOXHLET EXTRACTOR METHOD. THEN VIA GAS CHROMOTOGRAPHY WITH ELECTRONIC CAPTURE DETECTOR (G.C./E.C.), THE ION OR PCB CONCENTRATIONS WERE GRAPHED. THIS IS A DIFFICULT ANALYSIS, REQUIRING AT LEAST 24 HOURS FOR COMPLETION.

THE STANDARD PROCEDURE DURING THE DREDGING OPERATIONS WAS FOR THE DREDGE TO OPERATE IN OR COVER A SPECIFIC AREA, THEN EPA WOULD SAMPLE REMAINING SEDIMENTS AND RUN THE ANALYSIS TO SEE WHAT CONCENTRATIONS, IF ANY, OF PCB REMAINED. ON ALL OF THE SLIP EXCEPT THE POINT OF IMMEDIATE SPILL, SATISFACTORY REMOVAL WAS ACCOMPLISHED BY ONE DREDGING. AT THE POINT OF THE SPILL, HOWEVER, APPROXIMATELY 3 DAYS DREDGING WERE REQUIRED AND DEPTHS UP TO 10 FEET WERE DUG. AT THIS POINT, THE HIGHEST CONCENTRATIONS (UP TO 200 PPM PCB) WERE ENCOUNTERED.

THE UNIVERSITY OF WASHINGTON, DEPARTMENT OF OCEANOGRAPHY, WAS SUBCONTRACTED BY EPA TO MONITOR THE DREDGING EFFECTS ON THE WATER COLUMN IN THE ADJACENT DUWAMISH RIVER. UNDER THE DIRECTION OF DR. SPYROS PAVLOU, THE UNIVERSITY'S VESSEL STREETER WAS ANCHORED AT POINT SAMPLING LOCATIONS DOWNTIDE FROM THE DREDGING OPERATIONS. ALTHOUGH THE FINAL REPORT HAS NOT BEEN FURNISHED TO DATE, PRELIMINARY INDICATIONS ARE THAT DREDGING EFFECTS WERE NOT DETECTED, WITH THE EXCEPTION OF ONE SURGE CAUSED BY VESSEL WHEELWASH RATHER THAN THE DREDGING EQUIPMENT. IN ESSENCE, THIS CONFIRMS THE ABILITY OF THE PNEUMA SYSTEM TO DREDGE WITH MINIMUM DISTURBANCE OR TURBIDITY.

PCB

FLOCCULENT & FILTERING OPERATIONS

FILTERING OPERATIONS: ALL OF THE WATER PUMPED IN THE DREDGING OPERATION, AFTER SETTLING OF THE SOLIDS, WAS RUN THROUGH A FILTERING PROCESS PRIOR TO DISCHARGE INTO THE DUWAMISH RIVER. FILTERING CONSISTED OF PARTICLE FILTRATION BY USE OF A "FILTERITE" #264 MSO FILTER. THIS FILTER HAD FROM 600-1,500 GALLON/MINUTE CAPACITY. IT UTILIZED 81 TUBE-TYPE 30-INCH LONG CARTRIDGE FILTERS. THESE FILTERS WERE DISPOSABLE. WHEN THEY PLUGGED UP TO THE EXTENT THAT A PRESSURE DROP OCCURRED ACROSS THE UNIT, THEY COULD BE DISPOSED OF AND REPLACED WITH NEW FILTERS. COST OF FILTERS WAS APPROXIMATELY $3.30 EACH. FIVE FILTER CHANGES WERE UTILIZED DURING THE FILTERING OPERATION. FILTERS WITH DIFFERENT MICRON OPENING SIZES WERE TRIED. THE 10-MICRON FILTER PROVED TO BE MOST EFFECTIVE.

AFTER PARTICLE REMOVAL BY THE FILTERITE FILTER, THE EFFLUENT WATER WAS RUN THROUGH A SMALL EQUALIZING POND AND PUMPED THROUGH THE EPA PHYSICAL/CHEMICAL TREATMENT UNIT. THIS UNIT CONSISTED OF 3 BANKS EACH OF SAND FILTERS AND ACTIVATED CHARCOAL FILTERS. BECAUSE OF ADEQUATE PARTICLE REMOVAL BY THE PARTICLE FILTER, THE SAND BANK FILTERS WERE NOT UTILIZED. PREVIOUSLY, THE THREE SAND BANK FILTERS AND ACTIVATED CHARCOAL FILTERS HAD ALWAYS BEEN RUN IN SERIES, WITH A 200 GALLON/MINUTE MAXIMUM FLOW CAPACITY. WITH THE DREDGE PUTTING OUT UP TO 25,000 GPM FOR THE 8- TO 10-HOUR WORK DAY, 200 GALLON/MINUTE ROUND-THE-CLOCK FILTERING OPERATIONS WOULD NOT KEEP UP. THE

UNIT WAS SWITCHED OVER SO THAT THE 3 CHARCOAL FILTERS COULD BE RUN IN PARALLEL, THEREBY OBTAINING 600 GALLON/MINUTE FLOW. THIS WAY, WITH ROUND-THE-CLOCK FILTERING OPERATIONS, THE FILTER PLANT COULD KEEP UP THE 8- TO 10-HOUR/DAY DREDGE PRODUCTION. EPA'S TESTING INDICATED THAT GENERAL PCB CONCENTRATION IN THE SLUDGE BEING PUMPED INTO THE DISPOSAL PITS WAS 8-10 PARTS/MILLION. THE DECANTED WATER CONTAINED APPROXIMATELY 4 PARTS/BILLION AND, AFTER THE TOTAL TREATMENT, CONCENTRATIONS IN THE RETURN WATERS WERE IN THE NEIGHBORHOOD OF 50 PARTS/TRILLION. AFTER COMPLETION OF THE FILTERING, RETURN WATER WAS RETURNED TO THE DUWAMISH WATERWAY.

PCB - OVERALL EVALUATIONS

Overall Operations: PCB dredging and disposal operations were accomplished on a very tight schedule during the month of March. Disposal site diking was started on 16 February and completed by 1 March. Dredge setup and pipeline laying took until 4 March. 5 March was the first day of dredging operations. Washington State Department of Fisheries required that dredging be completed by 31 March, prior to their release of downstream fingerling migrants. Dredging was completed by noon, 30 March 1976, when EPA testing indicated the PCB had been removed satisfactorily. Filtering operations in the disposal area continued until 12 April 1976.

Pneuma System Evaluation: The Pneuma System worked satisfactorily for its application to this dredging. It is a special tool that has many varied applications. An advantage is that it can be transported over land on trucks, assembled, operated from land or floating cranes and set up to operate in many various fashions, depending upon the work requirements. Additional power can be added relatively easily with the addition of another compressor. One must be careful in selecting this piece of equipment, to assure themselves that the materials to be dredged are fluid, free flowing or dredge easily, as the system has no mechanical cutter. Downstream monitoring indicated that exceptionally low turbidity does exist in the vicinity of the dredge pump. Trashy or junky dredging areas will greatly increase the dredging time. Approximately 4 hours is required to disassemble and clean valves should they be plugged by trash. In fluid or low viscosity materials, the high concentrations of solids can be obtained.

THE DREDGING TIME WAS 81 HOURS OR 36% OF THE WORKING HOURS. THE LOW EFFECTIVE TIME WAS DUE MAINLY TO PERSONNEL ON THE BOAT WHO WERE NOT FAMILIAR WITH DREDGING OPERATIONS. APPROXIMATELY 3 DAYS WERE LOST DUE TO VARIOUS MECHANICAL REPAIRS TO THE DREDGE AND ASSOCIATED EQUIPMENT.

CONCLUSION: THIS WAS A PARAMOUNT OPERATION IN THAT IT IS:

(A) THE FIRST TIME THE CORPS OF ENGINEERS HAS UTILIZED THE PNEUMA SYSTEM,

(B) THE FIRST MAJOR DREDGING OPERATIONS UNDERTAKEN IN THE UNITED STATES TO REMOVE PCB,

(C) THE FIRST TIME EFFLUENT FILTERING HAS BEEN UTILIZED IN CONJUNCTION WITH DREDGING OPERATIONS.

FINAL EPA REPORT IS NOT PUBLISHED TO DATE. PRELIMINARY INDICATIONS FROM THE ANALYSIS MADE DURING AND POST-DREDGING ARE THAT OVER 200 OF THE 250 GALLONS SPILLED WERE RECOVERED BY THE 2 CLEANUP OPERATIONS. INDICATIONS ARE THAT 80-90 PER CENT RECOVERY HAS BEEN OBTAINED. THIS, IN LIGHT OF THE YEAR AND A HALF TIME LAPSE BETWEEN THE SPILL AND THE FINAL CLEANUP OPERATIONS, IS EXCEPTIONALLY GOOD. BACKFILL OF THE OPEN DISPOSAL PITS REMAINS UNTIL SUITABLE SUMMER WEATHER OCCURS. THIS MINOR PORTION OF THE WORK IS SCHEDULED FOR COMPLETION IN AUGUST OF 1976.

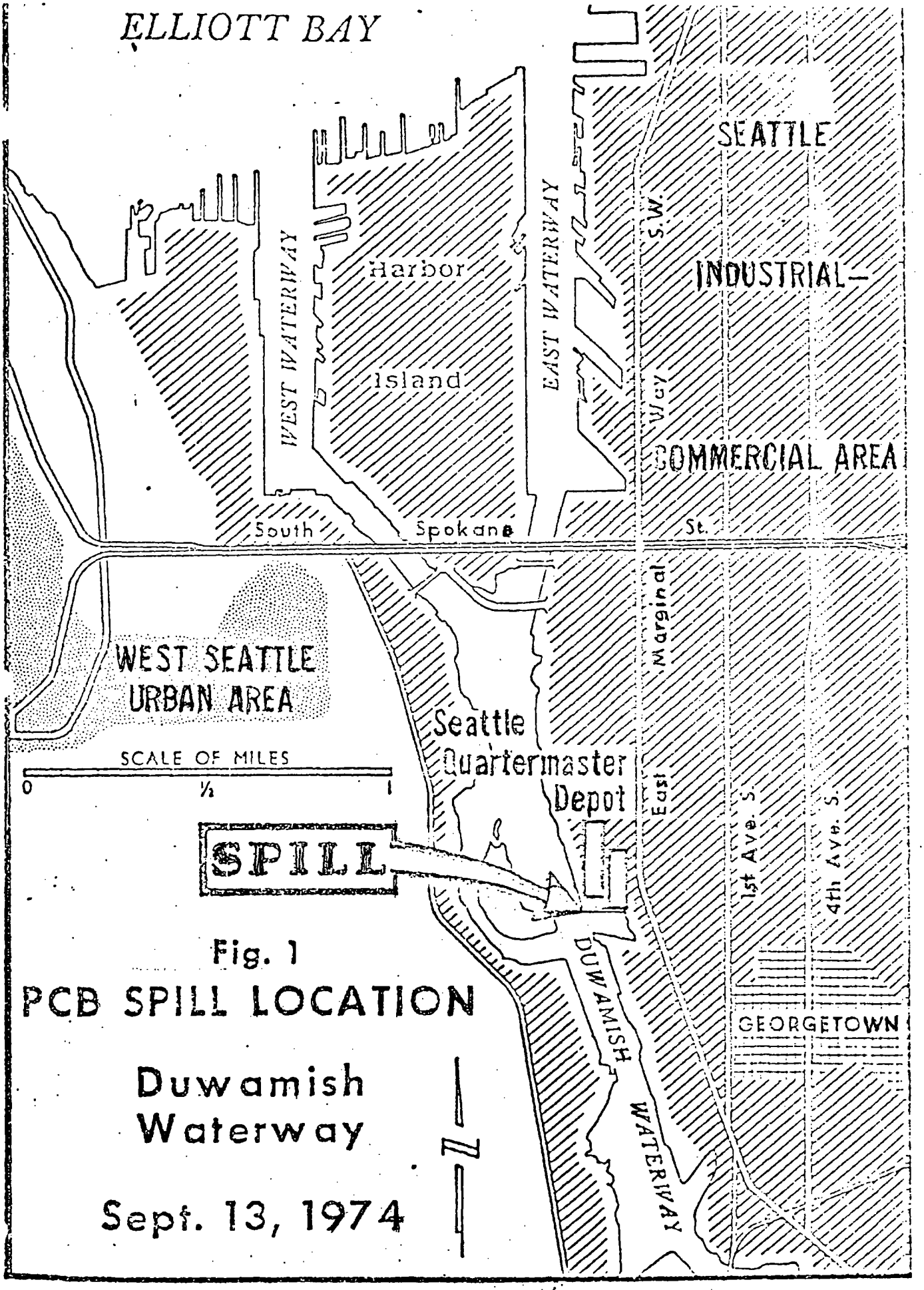


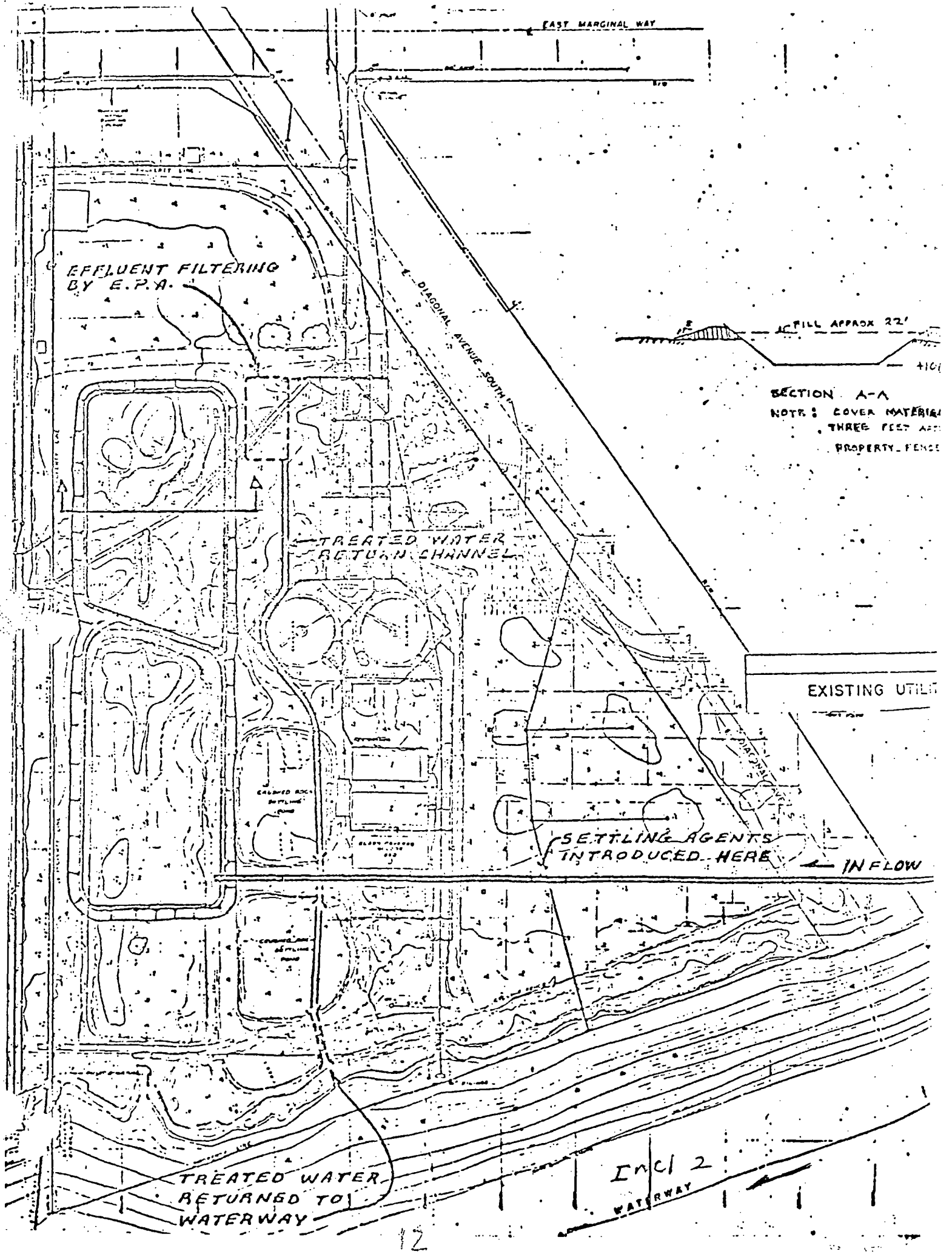
Fig. 1

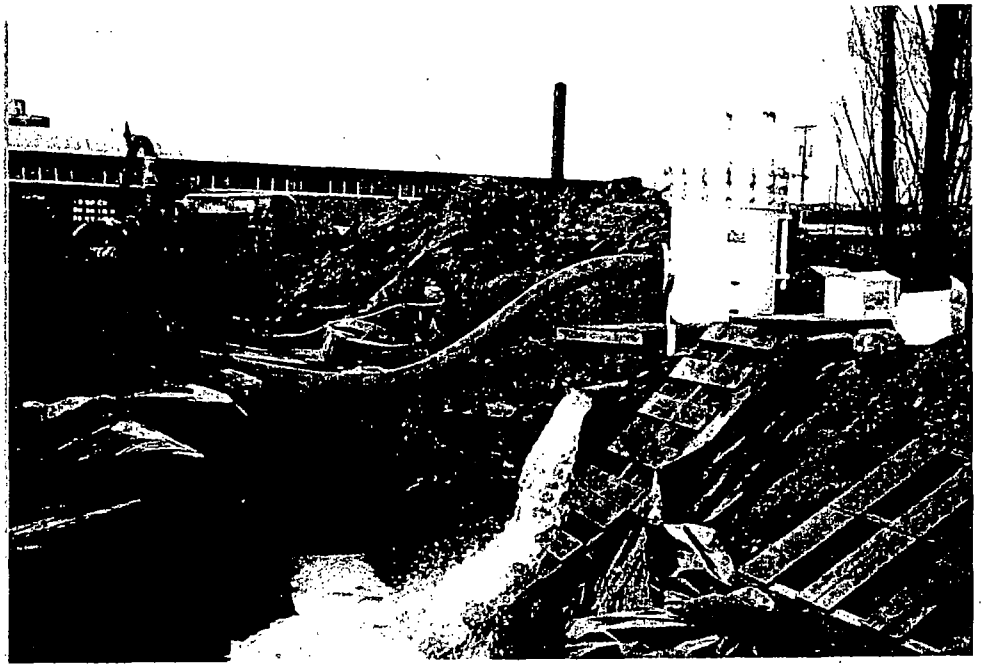
PCB SPILL LOCATION

Duwamish Waterway

Sept. 13, 1974

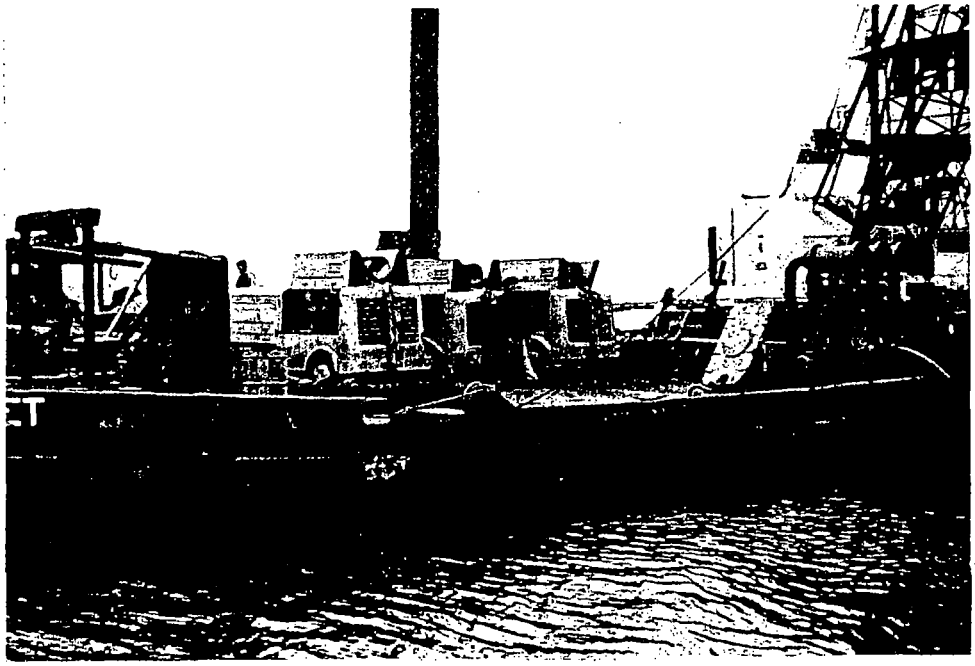
Incl 1


EAST MARGINAL WAY
EFFLUENT FILTERING BY E.P.A.
DIAGONAL AVENUE SOUTH
FILL APPROX 22'
SECTION A-A
NOTE: COVER MATERIAL
THREE FEET
PROPERTY FENCE
TREATED WATER RETURN CHANNEL
EXISTING UTILI
SETTLING AGENTS INTRODUCED HERE
INFLOW
TREATED WATER RETURNED TO WATERWAY
Encl 2
WATERWAY

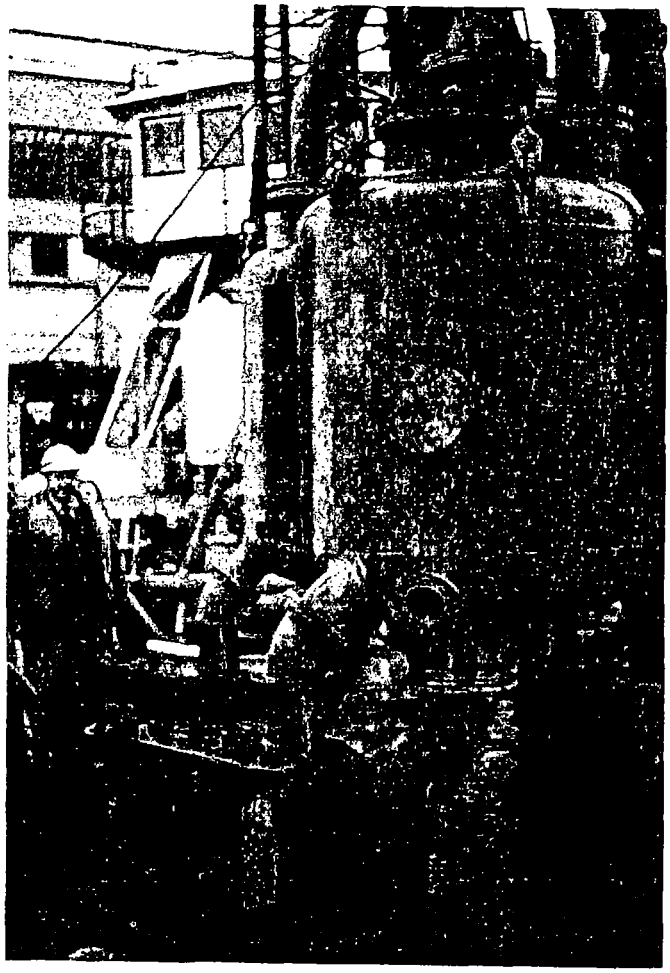


Filterite #264 MSO filter

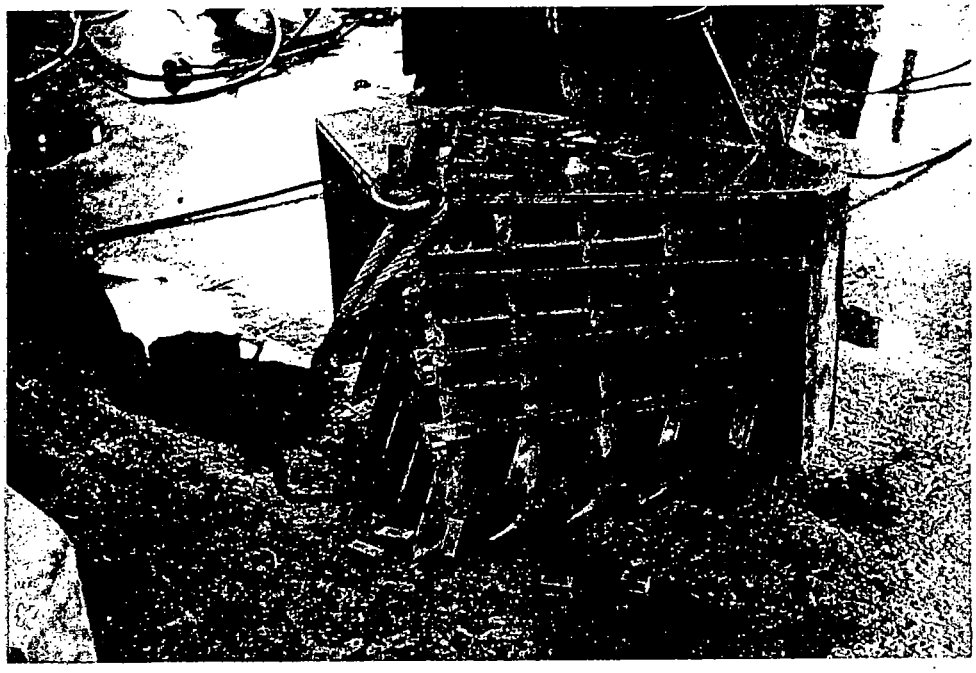
EPA physical/chemical treatment unit



Compressors and distributor aboard PUGET



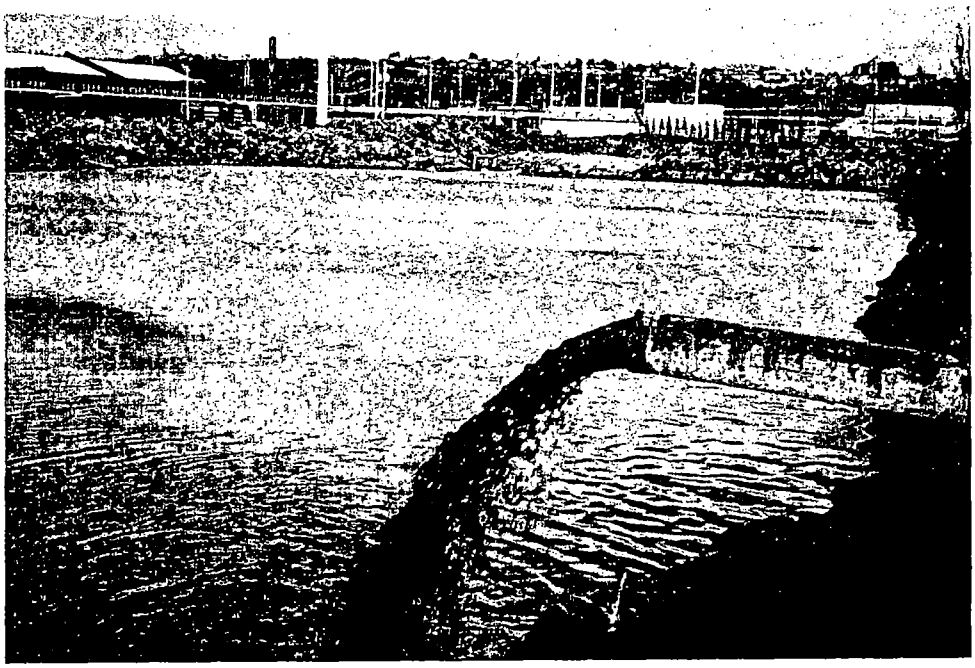
Pneuma cells and intakes



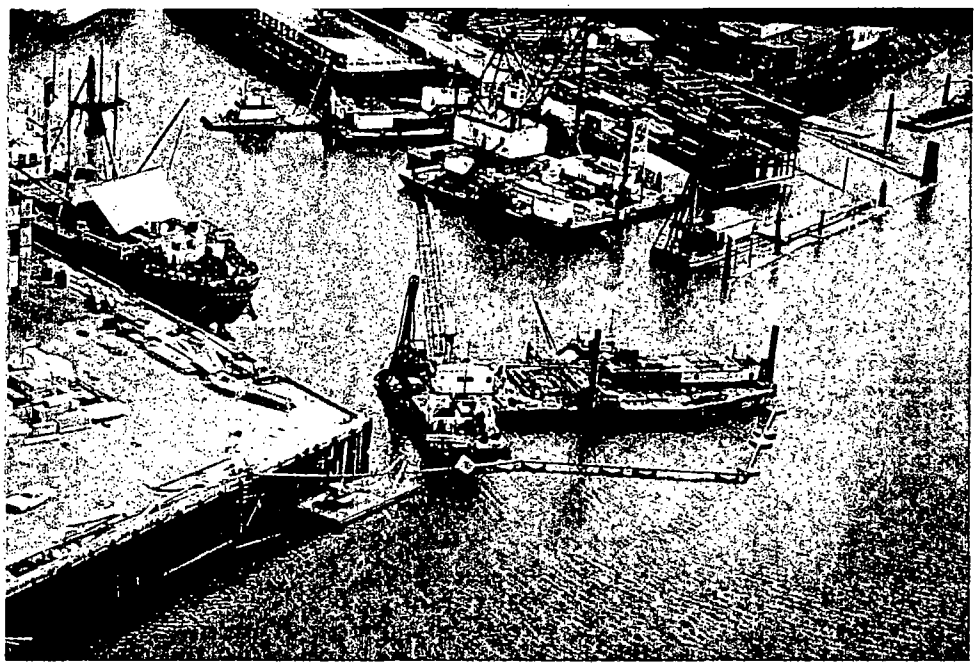
Intake after bars placement to reduce trash intake

Nalco flocculent being introduced into dredge pipeline

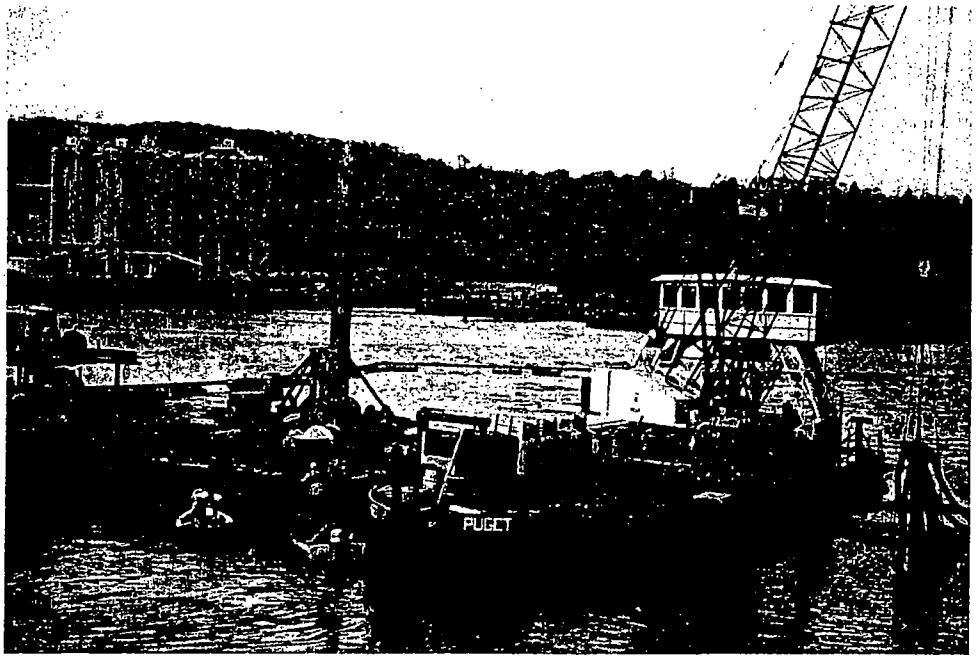
Dredge pipeline



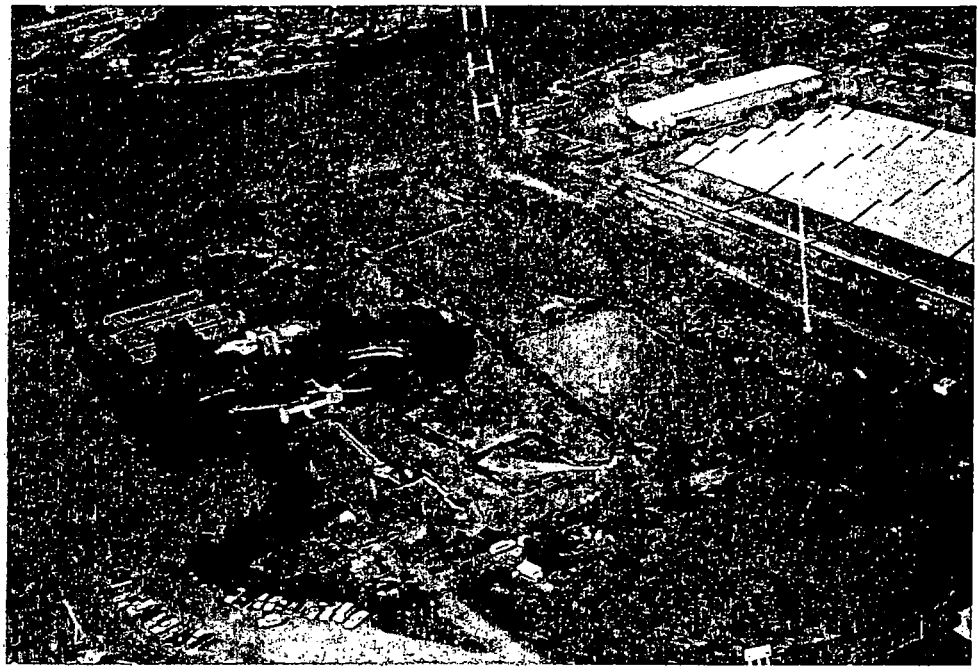
Pipeline discharge and Pond #1



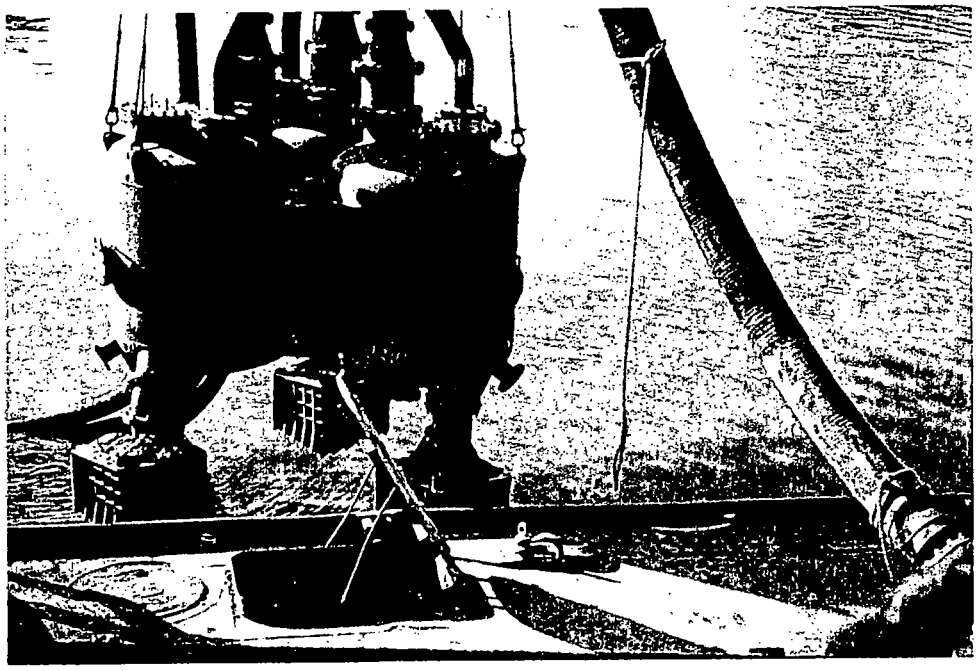
Aerial view showing PUGET with Pneuma system and spud barge



Pneuma system mounted on PUGET



Aerial view of Disposal Area



Pneuma system suspended by crane